

THE MINERAL INDUSTRY OF FINLAND

By Harold R. Newman

Mineral legislation and regulations are covered under the Mining Act (Kaivoslaki 503/65), the Mining Decree (Kaivosasetus 663/65), and Amendments to the Mining Law (1427/92, 1625/92, 474/94, 1571/94, 208/95, 561/95, and 1076/95). These are referred to collectively as the “Mining Law.” The mineral resources covered by the Mining Law include about 50 metal minerals and 30 industrial minerals, as well as gems and soapstone (Kortman and Others, 1996).

In Finland, any individual, corporation, or foundation having its principal place of business or central administration within the European Union (EU) enjoys the same rights to explore for and exploit mineral deposits as any Finnish citizen or corporation. This has encouraged foreign investment and increased exploration activities of major and junior companies. Exploration emphasis was on base metals, diamond, and gold deposits.

Government involvement in the mineral industry was considerably higher than in any of the other EU countries. Government-owned companies—Finminers Group (hard-rock drilling, materials handling, and ore processing), Kemira Oy (chemicals), Outokumpu Oyj (base-metals mining and mining technology), and Rautaruukki Oy (steel production)—dominated the domestic mineral industry, and Government organizations—the State Geologic Research Institute and the State Technological Research Center—were active in exploration and research. Because of Outokumpu and Finminers, Finland was a world leader in the technology of underground mining, ore processing, and metallurgy.

The country has well-established mining, mineral processing, and refining industries. The diminishing supply of indigenous metalliferous raw materials, however, required that most of the feed for smelters (100% of iron ore concentrate, 80% of zinc concentrate, and 60% of nickel matte and concentrate) be imported from various sources. Major mineral commodities produced are listed in table 1.

The major companies are listed in table 2. Outokumpu’s Kemi Mine, the only chromite mine in Finland, was a significant chromite producer. In 1998, output was around 1 million metric tons per year of chromite ore from two open pits. The ore was processed by a multistage concentration method that is based on the specific gravity between the minerals, as well as on their magnetic properties. The output of about 400,000 metric tons per year (t/yr) of chromite concentrates was used as raw material at Outokumpu’s ferrochrome and stainless steel plants at Tornio.

An expansion program was announced for the Kemi Mine. Starting in 1999, the open pit operation was to be prepared for underground mining. This expansion program was to take place during a 5-year period and was expected to improve cost effectiveness and to enable mine output to be doubled. An investment of \$80 million during the next 5 years was planned.

The chromite deposit occurs within a layered intrusion and contains an estimated 70 million metric tons (Mt) of reserves and additional resources of about 150 Mt (Mining Journal, 1998).

Although it has no primary copper mines, Finland produced copper as an associated mineral from Outokumpu’s primary zinc mine at Pyhäsalmi. Outokumpu’s blister copper capacity was 160,000 t/yr; cathode copper capacity, 125,000 t/yr; and nickel capacity, 32,000 t/yr. Overall, Outokumpu produces more than 1% of the world copper (Outokumpu Oyj, 1998, Products—Copper, accessed June 29, 1998, at URL <http://www.outokumpu.fi/basemetals/copper.htm>).

Finland has never been a major gold producer, although several domestic and foreign companies and the Geological Survey of Finland (GSF) explored for gold in 1998. Activity was mainly centered on the Lapland Greenstone Belt and the Archean Greenstone Belt of eastern Finland and the Svecofennian Schist Belt in the south.

In June 1996, Terra Mining AB started open pit gold operations at the Pahtavaara Mine. At the end of 1996, they were taken over by William Resources Inc. of Canada. Williams achieved full production in 1997. Gold mineralization occurs within a distinct talc/chlorite alteration zone, which is up to 100 meters (m) wide and appears to be a typical splay structure related to a major east-west shear zone. Within this alteration zone, gold is present in quartz-barite vein zones up to 10 m wide. Geologically, the style of mineralization is very similar to shear-zone-hosted gold deposits related to major breaks in the Canadian Shield of North America (William Resources Inc., [1998], Pahtavaara Mine, accessed July 8, 1999, at URL <http://www.info-mine.com/william.htm>).

The Pahtavaara Mine, which was scheduled for closure at the end of the second quarter of 1998, continued mining for the remainder of the year. Sufficient additional reserves were identified to continue into 1999 (William Resources Inc., November 13, 1998, William produces 36,000 ounces in third quarter at a cash cost of \$295 per ounce, accessed July 8, 1999, at URL http://www.williamres.com/html/news_releasenovember1398.htm).

The only remaining domestic nickel mine in operation in 1998 was Outokumpu’s Hitura Mine, which has produced more than 8 Mt of ore since 1965. The company announced that it was suspending production at Hitura from June 1998 owing to the decline in nickel prices. The mine remained closed the rest of the year (Metal Bulletin, 1998b).

All steel production in Finland was from imported concentrates and iron pellets. Two-thirds of the raw material came in the form of fines from Sweden’s Luossavaara-Kiirunavaara AB. The balance came from Russia in the form of iron pellets from Kostamus and fines from Olenogorsk. The

Finnish Government completed the sale of a portion of its shares in steelmaker Rautaruukki Oy, thus reducing its stake in the company to 41.78% (Metal Bulletin, 1998a).

A new ladle furnace and vacuum degassing plant, which plays a major part in the production of higher quality steels, was built by Rautaruukki Oy. The ladle furnace will be used to reduce impurity contents of steel, to increase freedom from slag inclusions, and to improve uniform quality. Vacuum degassing makes it possible to produce very clean steels. Rautaruukki expected that its production program could be supplemented by completely new steel grades beginning in 1999 (Rautaruukki Oy, September 22, 1998, Rautaruukki commissions a new ladle furnace and vacuum degassing plant, accessed March 15, 1999, at URL <http://www.rautaruukki.fi/whatnew/pr/pr2209.htm>).

The only mine producing zinc in 1998 was Outokumpu's Pyhäsalmi Mine at Pyhajarvi. The zinc concentrate was shipped to the Kokkola smelter, and the associated copper concentrate was shipped to the Harjavalta smelter. Pyhäsalmi, together with Outokumpu's Tara Mine in Ireland, supplied about 80% of the feed for the Kokkola smelter.

Outokumpu, one of the world's largest producers of zinc, announced that it would make a total investment of about \$90 million in the zinc plant in Kokkola, whereby the production capacity would be increased by about one-third from 170,000 to 225,000 t/yr of zinc. Implementation was expected to take about 2 years. Use of a new direct method of leaching zinc concentrates, developed by Outokumpu, was expected to improve metal recovery and to increase friendliness to the environment (Engineering and Mining Journal, 1999).

Finnacement Oy, a Scancem subsidiary, was the only cement producer in Finland. It operated two plants located in southern Finland. The largest plant was at Pargas, and the second, near the border with Russia. A growth in cement volume of about 21% during the first half of 1998 was more than the two plants could handle, and domestic production had to be supplemented by imports from other Scancem works, specifically Slite in Sweden and Kunda in Estonia (International Cement Review, 1998).

Malmikaivos Oy discovered a series of kimberlite bodies in northern Finland. Malmikaivos, a fully owned subsidiary of Ashton Mining Ltd. of Australia, discovered 24 kimberlite pipes and bodies, 15 of which were diamondiferous. Four had grades of more than 10 carats per 100 metric tons. A joint-venture agreement on the diamond projects was reached with Dia Met Minerals Ltd. of Canada. Dia Met can earn 60% equity by expenditure of \$2.7 million, with a minimum expenditure of \$1.4 million during the next 2 years (Northern Miner, 1998).

Kemira Agro Oy operated the largest mine in Finland at Siilinjärvi to produce apatite concentrate for a nearby fertilizer plant. The deposit is an Archean carbonate with a 10% apatite content. Agricultural limestone and phlogopite were produced as byproducts. Gypsum, a waste product of the fertilizer plant, was processed for paper pigment (Pekkala, 1998, p. 57).

Finnminerals Oy was sold to Western Mining Corp. Holdings Ltd. of Australia (50%) and Plüss-Staufer AG of Switzerland (50%) and became the joint-venture company Mondo Minerals Oy. The company was the largest producer of paper-grade talc in Europe and Finland's sole producer of talc. Mondo operated three talc mines and beneficiation plants (Pekkala, 1998, p. 59).

GSF placed emphasis on exploration for pigment minerals, such as ilmenite, high-quality carbonates, and kaolin. Also, a number of dimension stone deposits were being assessed by various companies.

SP Minerals Oy, a joint-venture company of Partek Nordkalk Oy (50.1%) and SCR-Sibelco SA of Belgium, was responsible for the processing and marketing of quartz and feldspar products, molding sand, and bentonite. The main markets are the glass, ceramic, and construction material industries, as well as foundries in Finland and northern Europe. In a separate operation, Partek also produced about 20,000 t/yr of wollastonite from the Lappeenranta deposit for use in the ceramic and plastics filler industries (Houssa, 1998).

Finland was one of the largest energy consumers in western Europe. Only about one-third of its energy requirements were satisfied by indigenous sources; namely, hydro and nuclear power, peat, and wood. All other energy sources, such as coal, natural gas, and petroleum, were imported.

The operating environment in Finland was generally favorable for exploration and mine development. GSF identified a number of mineral deposits for which information was available. The country has a long mining history and a traditional focus on primary resources, such as mining, forestry, and farming. Finnish mining equipment manufacturers were recognized throughout the world's mining community.

Finland can be considered to be an attractive exploration target in several respects based on information available from GSF. Geoscientific data coverage is excellent, infrastructure is highly developed with good port facilities, the high-voltage power grid is extensive, and the road network is comprehensive. Taxation laws are favorable, and the mining law is strong as discussed above. Large areas can be considered to be under explored for many commodities, and the likelihood of additional discoveries may be enhanced with the entrance of foreign companies into the Finnish mineral industry. Lastly, the country is located in close proximity to major markets.

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Major Source of Information

Geological Survey of Finland
Betonimiehenkuja 4
02150 Espoo
Finland

TABLE 1
FINLAND: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
METALS					
Aluminum metal, secondary	35,466	35,090	35,308	38,200 r/	34,200 2/
Cadmium metal, refined	548	539	648	540 e/	550
Chromite:					
Gross weight:					
Lump ore e/ thousand tons	225	214	210	215	220
Concentrate e/ do.	341	373	360	365	380
Foundry sand e/ do.	7	11	12	9	10
Total do.	573	598	582	589	610
Cr ₂ O ₃ content:					
Lump ore e/ do.	76	80	70	75	75
Concentrate do.	150	150	150	150 e/	150
Foundry sand e/ do.	3	3	3	3	5
Total do.	229	233	223	228	230
Cobalt, metal, powder, and salts	1,443	1,709	2,110	3,000 r/	3,000
Copper:					
Concentrate, gross weight	34,410	26,000	24,000	22,000 e/	25,000
Mine output, Cu content	13,243	9,790	9,261	8,500 e/	9,500
Metal:					
Smelter	129,265	120,577	178,675	159,000 e/	156,000
Refined	69,177	73,700	110,715	116,000 e/	123
Gold metal kilograms	1,372	2,061	3,070	3,900 r/	5,000
Iron and steel, metal:					
Pig iron thousand tons	2,597	2,242	2,457	2,780	2,912 2/
Ferroalloys, ferrochromium do.	254	247	228	237 r/	231 2/
Steel, crude do.	3,419	3,176	3,301	3,687	3,932 2/
Semimanufactures, rolled do.	3,121	3,242	3,292 r/	3,314 r/	3,682 2/
Mercury	83	90	88	90 e/	80
Nickel:					
Concentrate, gross weight e/	107,865 2/	110,000	100,000	100,000	50,000
Mine output, Ni content	7,652	3,439	2,136	3,252 r/	1,200
Metal, electrolytic	16,902	21,268	28,815 r/	34,228 r/	43,000
Platinum-group metals:					
Palladium kilograms	96	95	182	180 e/	150
Platinum do.	37	37	62	60 e/	50
Selenium metal do.	30,000	29,690	42,000	40,000 e/	40,000
Silver metal do.	26,100	26,098	32,506	32,500 e/	29,700
Zinc:					
Concentrate, gross weight	41,971	43,000	58,000	60,000 e/	60,000
Mine output, Zn content	16,916	16,385	26,294	30,800 e/	30,700
Metal	173,200	176,600	176,300	175,300 e/	199,000
INDUSTRIAL MINERALS					
Cement, hydraulic thousand tons	864	907	975	960 e/	900
Feldspar	43,483	41,808	40,265	40,000 e/	40,000
Lime thousand tons	321	401	394	400 e/	400
Mica	5,591	--	--	--	--
Nitrogen, N content of ammonia	11,894	5,933	5,107	6,000 e/	6,000
Phosphate rock, apatite concentrate:					
Gross weight thousand tons	657	671	657	650 e/	650
P ₂ O ₅ content do.	236	243	240	235 e/	235
Pyrite, gross weight do.	839	829	813	950 e/	900
Sodium sulfate do.	36	34	29	30 e/	35
Stone, crushed:					
Limestone and dolomite:					
For cement manufacture do.	1,047	1,114	1,128	1,200 e/	1,200
For agriculture do.	898	787	892	900 e/	900
For lime manufacture do.	343	335	303	300 e/	300
Fine powders do.	382	316	289	300 e/	300
Metallurgical e/ do.	2	2	2	2	2
Total do.	2,672	2,554	2,614	2,702 e/	2,702
Quartz silica sand do.	71	30	31	30 e/	30
Soapstone do.	29	31	--	-- e/	--

See footnotes at end of table.

TABLE 1--Continued
FINLAND: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998 e/
INDUSTRIAL MINERALS--Continued					
Sulfur:					
S content of pyrite thousand tons	369	422	425	430 e/	430
Byproduct:					
Of metallurgy do.	216	215	291	290 e/	290
Of petroleum do.	41	37	38	40 e/	40
Total do.	626	674	754	760 e/	760
Sulfuric acid do.	1,084	1,159	1,287	1,200 e/	1,200
Talc do.	453	464	345	350 e/	350
Wollastonite	27,757	29,592	22,304	21,000 e/	20,000
MINERAL FUELS AND RELATED MATERIALS					
Peat:					
For fuel use thousand tons	6,960	6,300	6,000 r/	6,000 r/	6,000
For agriculture and other uses do.	1,040	750	600 r/	450 r/	500
Petroleum refinery products thousand 42-gallon barrels	80,486	79,000	83,000	82,000 e/	80,000

e/ Estimated. r/ Revised.

1/ Table includes data available through June 1999.

2/ Reported figure.

TABLE 2
FINLAND: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Apatite	Kemira Agro Oy (Government, 98%)	Mine and plant at Siilinjärvi	8,000
Ammonia	Kemira Oyj (Government, 98%)	Plant at Oulu	75
Cadmium, metal	Outokumpu Oyj (Government, 40% ; Insurance Co., 12.3%)	Smelter at Kokkola	1
Cement	Finnccement Oy (Scancem Group, 100%)	Plants at Lappeenranta and Pargas	1,200
Chromite	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Kemi	1,000
Copper:			
Ore, Cu content	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mines at Pyhäsalmi, Saattopora, and Hitura	10
Metal	do.	Smelter at Harjavalta	160
Do.	do.	Refinery at Pori	125
Feldspar	SP Minerals Oy (Partek Corp., 50.1%; SCR-Silbco SA, 49.9%)	Mine and plant at Kemiö	50
Ferrochrome	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Tornio	250
Gold:			
Ore, Au content tons	do.	Mine at Orivesi	4
Do.	do.	Williams Resources Inc.	3
Metal	do.	Smelter at Pori	4
Limestone	Partek Nordkalk Oy (Partek Corp., 100%)	Mines at Lappeenranta, Pargas and Parainen	1,500
Do.	Rauma-Repola Oy	Mine at Turpio	300
Mercury tons	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Kokkola	150
Mica	Kemira Oy (Government, 98%)	Mine at Siilinjärvi	10
Nickel:			
Ore, Ni content	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Hitura	3
Metal	do.	Smelter at Harjavalta	32
Phosphate-apatite	Kemira Oyj (Government, 98%)	Mine at Siilinjärvi	700
Do.	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Pyhäsalmi	800
Quartz and quartzite	SP Minerals Oy (Partek Corp., 50.1%; SCR-Silbco SA, 49.9%)	Mines at Kemiö and Nilsia	250
Selenium tons	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Pori	35
Silver	do.	do.	30
Steel	Rautaruukki Oy (Government, 41.8%)	Plant at Raahе	2,100
Do.	Fundia AB (Norsk Jenverk AS of Norway, 50%; Rautaruukki, 50%)	Plants at Aminnefors, Dalsbruk, and Koverhar	850
Do.	Ovako Oy (SKF, 50%; Wartsila, 25%; Fiskas, 20%)	Plant at Imatra	600
Talc	Mondo Minerals Oy (Western Mining Corp. Holdings Ltd., 50%; Plüss-Staufer AG, 50%)	Mines at Lahnaslampi, Lipsavaara, and Horsmanaho	500
Wollastonite	Partek Minerals Oy (Partek Corp., 100%)	Mine at Lappeenranta	30
Zinc:			
Ore, Zn content	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Pyhäsalmi	25
Metal	do.	Smelter at Kokkola	175